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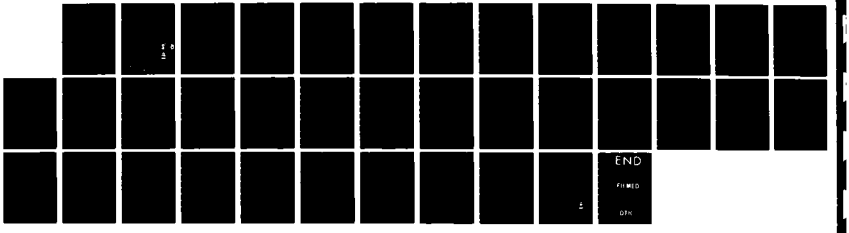

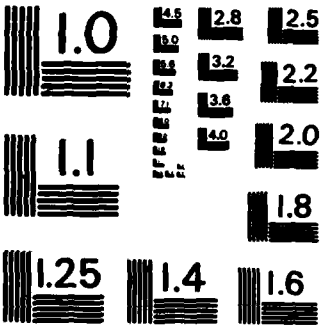

# Measuring Business Losses from Floods

by

Jerald R. Barnard

Contract DACW-25-84-Q-0169

Final Report to the U. S. Army Engineer District,
Corps of Engineers, Clock Tower Building
Rock Island, Illinois



The Institute for Economic Research
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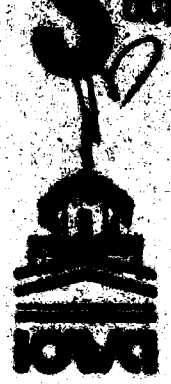

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# 1. INTRODUCTION

Flooding and other natural disasters destroy and damage capital and interrupt the production and income generating process. Accordingly, losses from flooding may include reduced national wealth and income over a given interval of time. This report focuses primarily upon developing a methodology for assessing and measuring the economic losses of production of goods and services as a result of flooding. The methodology for measuring the direct losses from flooding, the physical damage to property, is well established, hence will not be dealt with except in the general scheme of evaluating losses due to flooding.

The losses from flooding are measured using national income and wealth accounting concepts. The methodology is developed for application at the level of the individual firm and area economy. The procedures outlined provide a set of guidelines which an informed analyst can use to make estimates of the direct business losses, and thus make inferences of the employment and income impact on the local economy.

The general outline of this report is as follows. Section 2 reviews literature relevant to measuring economic loss from natural disasters. Section 3 deals with the measurement of business losses at the firm level. Section 4 develops the survey and procedure for estimating business loss. Section 5 presents the methodology for estimating the income and employment effect on the local economy.

## 2. RELEVANT LITERATURE

The relevant literature on flooding and flood loss is examined in this paper as a sub-set of the broader literature of natural hazards. Russell (1970) discusses the problem of defining and estimating a natural hazard (floods, earthquakes, hurricanes, tornados, etc.). Natural hazards are defined in relation to the existing human experience of extreme natural events relative to the norm of what society expects. A natural event becomes a hazard when extreme natural events come to impact on humans and/or human activity.

Researchers have taken a variety of approaches toward the measurement of losses from natural disasters. An investigation by Friesma, et al. (1970) employed what might be termed a change in growth path approach to measure the impact on communities. This approach was used to measure the long-run impact of disasters which struck four communities: Yuba City, California; Galveston, Texas; Conway, Arkansas; and Topeka, Kansas. The model design used was an interrupted time-series technique. Economic data series such as employment and personal income are constructed for ten years prior to the disaster event and ten years after. The technique measures whether the behavior of the time-series data after the event represents an undisturbed continuation of the series from its previous time path. The expected level of the variable represents an uninterrupted continuation of the trend. The difference between observed and expected levels represents the measured impact of the disaster event. The authors point out that Title V of the Disaster Relief Act Amendment of 1975 creates on paper a federal role in assisting stricken communities with long-range economic recovery. The authors conclude that the measured impact of the disaster is not significant because the rebuilding

process leaves the community with a new capital stock which tends to give it a competitive edge over what it had prior to the disaster.

A study by Rossi, Weber-Barden, and Pereira (1983) examined a sample of disaster impacted communities and concluded there appears to be no difference in population and housing growth patterns with comparable communities that were not subjected to natural disaster. Household resources, including insurance, community resources, and outside help from state and federal governments, were sufficient to restore impacted areas to normal growth patterns. This study focused on impacted households rather than the community as a whole. Their reasoning for using this approach is that the typical natural disaster affects only a small portion of the households in the community or urban area. Accordingly, the disaster impact on the affected households tends to be swamped by examining aggregate economic indicators such as a change in urban area employment. A survey was conducted of 1400 households which claimed to have been affected by a natural disaster. Their findings included:

- Average damage costs of flood victims per household is about $8,000 (in 1980 dollars).
- Households not covered by insurance usually obtain aid elsewhere.
- Many households claimed to have incurred increased debt as a result of the disaster.
- On average floods affect 0.34 percent of U.S. households annually.

Property value analysis is another method that has been used to measure losses resulting from natural hazards such as flooding. Domianos and Shabman (1976) examined the influence of flood risk on residential land value. Barnard (1978) measured the impact of changing flood hazard from urban development in the Ralston Creek watershed (Iowa City) on residential property

values. Both studies indicate that flood hazard has a negative impact on property values. The Barnard study was able to breakdown the decline in property value due to flood hazard into two components, (1) the expected damage from hazard, and (2) the discount associated with flood hazard risk.

The need to establish a baseline against which the impact of a disaster is to be measured is considered by a number of researchers. Haas, Kates and Bowden (1977) make this point. They indicate that after a disaster, public officials typically speak of rebuilding to make the city better than it was before. The consequence of this is to seriously affect attempts to estimate the longrun impact of a natural disaster without an adequate baseline estimate.

Kates (1965) developed a methodology for measuring industrial flood losses. He proposes production losses be measured on the basis of value added. To estimate business losses he developed a methodology of synthesizing flood loss estimates using stage damage functions wherein the flood stage in feet is translated into days of production loss. Estimates of damages in lost value added are computed for an establishment account (the flood impacted plant) and for the national account (the impact at the national level). Time deferral measures of the amount of lost production deferred into the future were developed from plant managers and applied to the production loss estimates at both the establishment and national level.

A recent study by Ellson, Milliman and Roberts (1984) is a major contribution to measuring the economic impact of natural disasters. This study specifically approaches the baseline issue and establishes that the appropriate comparison of the level of economic activity as a result of a disaster is the comparison of "with and without," rather than "before and after." This approach emphasizes a methodology that focuses, first, on the

short-run regional economic effects resulting from damage loss, and second, the long-run effects on growth patterns of regional income and employment relative to a baseline forecast. While the article specifically addresses the measurement of the economic effects of earthquakes, the methodology is generally applicable to other types of natural disasters.

The Ellson, Milliman and Roberts study develops an econometric model for measuring the impact of disasters, and provides simulations of the time path of the economy under baseline and alternative damage scenarios. The econometric model is developed as a simultaneous system of the Charleston, S.C. metropolitan area (with interaction among the three counties of the metro area). The model is constructed in such a way that it can deal with supply side constraints as a result of damage to the regional capital stock and transportation system. Also, the model makes possible the measurement of the loss of capital stock and the pattern of income and employment growth under alternative scenarios. Finally, the model facilitates measuring stock and flow concepts as well as aiding in the computation of the present value of the income and capital series since it provides explicit forecasts of the major economic variables.

The Ellson, Milliman, Roberts study provides an interesting set of impact simulations. They begin with a baseline forecast of activity without an actual event, or threat of an event. Three disaster type events are simulated: an unanticipated event, an anticipated event, and a false alarm prediction. These simulations provide time paths of income, employment, population, and changes in the stock of housing and capital. Present value of regional losses with replacement of housing and capital are also determined. The event simulations provide interesting comparisons of the impact of earthquakes, or predictions of earthquakes, on the time path of income and

employment, and on losses of capital stock and its subsequent replacement. The simulations show clearly how a disaster can cause major losses in wealth as a result of destroying or damaging the capital stock, and how the subsequent rebuilding can increase income and employment. Of particular interest is the simulation of the false alarm prediction. This simulation results in the curtailment of investment and causes a reduction in current income and employment. Also, it does not generate the levels of employment and income after the alert has been lifted that would have occurred if there had actually been an earthquake.

This review of literature related to business flood losses is indicative of the various approaches taken to measure the impact of flooding. The key points in the evolution of methodology to assess business losses from flooding focus on the following points:

1. Early studies pursued a before-after approach as opposed to a preferred strategy of developing a baseline study by which a with and without comparison of damage can be measured.
2. Researchers indicate the need for an economic model of the economy to evaluate and assess the impact of a natural hazard event. The development of regional economic modeling techniques has progressed to the point this is feasible but still quite costly in terms of time and money.
3. The measure of lost economic activity can be done in various units of account, such as employment, capital stock, and value added which is consistent with our national income accounts. Value added is a preferred measure in that it is a comprehensive measure consistent with our national accounts and eliminates the chance of double counting.

# 3. MEASUREMENT OF BUSINESSES LOSSES

This section develops a methodology for measuring the lost output and income as a result of flooding that is consistent with national income accounting measures. Eckstein's (1958) pioneering study in water resources discusses the measurement of the indirect flood losses, i.e., the losses of production of goods and services. The approach used in this study is to link conventional accounting measures to national income accounting concepts and measures. Also, the approach is to use measures for which industry statistics by SIC code (Standard Industrial Classification Codes) are available for comparison purposes.

## 3.1. National Income Accounting Measures

The national income accounts have become the standard by which we measure the performance of the economy. The measures link standard accounting measures (measures used in connection with tax reporting) and economic measures of the firm so as to develop aggregate measures of the national economy. The national income and product accounts provide a comprehensive and internally consistent set of accounts whereby the aggregate income and production of the economy can be measured for a specific unit of time.

The major components of the national income and products accounts are shown in Table 1. The income components are listed on the left hand side. They represent the sources of income originating from production--the compensation of workers and proprietors, rents and net interest, the corporate profits and addition to inventory, capital consumption allowances

Table 1. The Gross National Income and Product Accounts

| Gross National Income | Gross National Product |
|---|---|
| Compensation of employees | Personal consumption expenditures |
| Rental income of persons | Gross private domestic investment |
| Net Interest | Government purchase of goods and services |
| Proprietor's income | Net exports of goods and services |
| Corporate profits and inventory valuation adjustment | |
| Business transfer payments | |
| Capital consumption allowance | |
| Indirect business tax and nontax liability | |
| Less: Subsidies less current surplus of government enterprises | |
| Gross National Income | Gross National Product |

(depreciation), indirect business taxes, less subsidies to business, less current surplus of government enterprises.

The Gross National Product is the summation of sales of final goods and services. It includes personal consumption expenditures, private domestic investment, government purchase of goods and services, and net exports of goods and services (exports minus imports). The income generated in production is equal to the final goods and services produced, i.e., the Gross National Income equals the Gross National Product.

Value added is a measure of the contribution of a given sector, firm, or establishment to the gross national income and product. It is defined as the value of production minus cost of intermediate inputs used in production (materials, supplies, containers, fuel, electricity, contract work, etc.). It measures, as its name implies, the value added to the product or service being produced. It eliminates double counting that would take place if inputs used in the production process were not subtracted from the gross output, value of shipments, or sales measure of the firm. An example of the value added concept is depicted in Table 2. The typical loaf of bread has gone through four stages of production: the production of wheat, the production of flour, the production of bread, and the production of marketing services. The value of the final product, bread at retail, measures the contribution to gross national product of bread. The sum of value added at each stage of production (the gross national income) equals the contribution to gross national product.

To elaborate on the value added concept, the claims against output which make up the value added measure in the double entry system of accounts are shown in Table 3. The claims against output provides the detail of services of labor, capital and government in the production process. Employee compensation measures labor services; profits, net interest, and depreciation

Table 2. Example of Final, Intermediate Goods and Value Added

| | Seller | Buyer | Selling Price | Value Added |
|---|---|---|---|---|
| Bushel of Wheat | Farmer | Flour Mill | $ 3.00 | $ 3.00 |
| Bag of Flour | Flour Mill | Bakery | 4.00 | 1.00 |
| 10 Loaves of Bread | Bakery | Retailer | 7.50 | 3.50 |
| Bread at retail | Retailer | Consumer | 10.00* | 2.50 |
| | | | $24.50 | $10.00** |

* Final sale of goods and services = $10.00

** Value added = $10.00

Table 3. Value added and claims against output for a hypothetical firm

| Value Added | Claims Against Output |
|---|---|
| Sales | Employee Compensation |
| Minus: Intermediate products and services purchased from other firms | Net interest |
| | Profits and inventory adjustment |
| | Depreciation |
| | Indirect business taxes |
| | Business transfer payments |
| Equals: Value added | Total: Claims against output |

measure the contribution of capital; and indirect business taxes measure the contribution of government services such as police and fire protection, education, etc.

To sum up, the use of the value added measure ties the measurement of losses at the firm level to the national income accounts. Also, it is useful in eliminating the measurement of intermediate product and service inputs. The components of value added are standard tax accounting measures for which summary statistics are reported for various industries by the Internal Revenue Service. This data can be useful, as will be seen later, in constructing estimates of damage where survey data are incomplete, or inadequate.

## 3.2. Impact of Flooding

This section examines the theoretical basis for evaluating the losses associated with the interruption of production and damage losses to plant, equipment and inventories.

There are two parts to the loss issue. The first is associated with the physical damage to plant and equipment and the loss of output to the firm. The other part involves how to measure this loss to the regional and national economy. Measuring the physical damage and production loss to the firm is reasonably straightforward. It is the second part, the measurement of losses in the regional and national economy, that we will focus on.

We begin by focusing on two cases. The first one will be designated as the general case and the second as the special case.

### 3.2.1. General Case: Competing firms in unaffected areas take up the slack

In the general case we consider a firm(s) producing non-differentiated goods and/or services subjected to a natural disaster. If we assume that the economy is at full employment equilibrium with firms carrying optimal inventories, the introduction of a natural disaster to an area will result in the cessation of production of the damaged firm(s) for a period of time, and the economy would draw from existing inventories to make up the decrease in output. The draw-down on inventories could only be replaced by non-damaged producers extending production so as to bring inventories back to optimal levels. This is possible because the U.S. economy often operates at less than full employment and industrial capacity utilization data also indicate idle capacity is generally present in the economy.[1]

As most natural disasters affect only a relatively small amount of national production, at any point in time, the loss of production would likely soon be made up. There is a need to distinguish between a continuous production process and a seasonal production process. In the continuous production case it would be possible to make up the lost production within the given accounting period of one year. For the seasonal production case, the opportunity to make up production may not be possible (e.g., a flooded establishment with a very short production season such as a cherry processing plant.) The period of time is of course an important point to be considered. In the very short-run, measured in days or in a few weeks, national production will be lost as a result of a shutdown due to a natural

---

[1] Research in the area of idle capacity by Winston and McCoy (1974) indicates that firms intentionally overbuild capital stock in response to input costs which vary rhythmically over time.

disaster. Over the longer period of a year (the period of time measurement used for standard accounting practices and tax purposes) the loss of output at the national level would likely be made up as unaffected producers would move to fill the loss of production, first from inventories, and then with expanded output to replace inventories.[2]

At the level of the local economy (a local labor market and shopping area) a natural disaster could have a significant adverse impact on income and employment. The loss of a few weeks or a couple of months production at firms employing a significant number of workers could be a major economic setback to the local economy, not only reducing income and employment for those directly affected but also spreading to other firms. This process can best be described using the economic base concept. This point will be discussed in Section 5.

### 3.2.2. Specific Case: No alternative source of supply

In the special case we consider a firm (a monopoly) which is the sole producer of a product with no substitutes. If this firm is subject to a natural disaster, clearly there is limited opportunity to use inventories to fill orders, except perhaps if the firm were to have inventories stored at other locations which were undamaged. Again the length of the production shutdown period would be of critical importance. As the length of down-time is extended, the more likely it would be that the firm would not be able to recover the lost production within the one year accounting time period. For

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[2] Kates (1965) uses a time deferral factor on production based on a survey of managers to determine production losses.

example, if a firm's production was down for nine months of a year then there is limited opportunity even with multiple shifts of regaining all of the lost production. There is still the opportunity, however, for the damaged firm to make up the lost output over a period of time longer than one year.

There is another consideration in examining the case of the monopoly. If a monopoly is shut down it would likely impact the firm's suppliers and users over the same period of time. Accordingly, the impact would spread to the chain of suppliers and users connected with the monopoly firm (typically a local or regional effect).

The impact on the local economy from the loss of income and employment as a result of a shutdown by the damaged monopoly would be the same as in the general case of the previous section.

# 4. ESTIMATION OF LOST PRODUCTION

The estimation of lost production under the general case for firm(s) shut down for a period of time because of flooding involves surveying the firms and determining (estimating) the loss of value added that would occur during the standard accounting period of one year, or longer if the damage should be extensive. The survey questionnaire would be used to identify the basic information on the firm's loss, and relate it to a consistent set of accounting and economic data. A basic survey questionnaire might entail the information specified in Tables 4 and 5 for commercial and industrial firms.

The objective of the survey of the firm is to determine the extent of damage to facilities and the loss of business activity as measured by value added. It is suggested the survey of production loss be measured on an average monthly basis. The items of information in the survey are straightforward; however, there is some need for elaboration of the value added measures. For the cost of labor item, proprietors and partners salary allowance should be included along with payroll and payroll taxes. Net interest is the difference between interest paid and any interest received on business operating balances. Estimated depreciation is consistent with the firm's reported depreciation for income tax purposes. Business taxes would include property taxes, excise taxes and corporate income taxes. Business transfer payments would include bad debts. Profit is perhaps the most difficult for the respondent to estimate for the current year and will typically be confused with proprietors salary. Nevertheless, the respondent can make an estimate based on the experience of the firm in the most recent year or two. In cases where information is extremely limited, estimates can be derived using ratios derived from the composite tax return data for firms

Table 4. Commercial Survey

Reach _____

1. Name _____

1a. Name of person providing information _____

2. Address _____

3. Type of business _____

4. Ground elevation _____ 5. Floor elevation _____

6. Zero damage elevation _____

7. Size of building (sq. ft. of floor space) _____

8. Basement _____ 9. Value of structure $ _____

10. Value of equipment & fixtures $_____ 11. Value of inventory $_____

12. Operations information: The data requested in the following part of this questionnaire refers to your best estimate of operations over the past year (or two-three years if your business operations are significantly different this year for reasons beyond disruption from flooding).

13. Sales of goods and services (Avg. monthly) $ _____

14. Number of employees (Avg. monthly) number _____

15. Cost of labor (Avg. monthly payroll including fringe benefits, proprietors/partner salary, payroll taxes) $ _____

16. Net interest (paid less received (Avg. monthly)) $ _____

17. Profit (Avg. monthly) _____

18. Depreciation (Avg. monthly) _____

19. Business taxes (Avg. monthly) _____

20. Business transfer payments (bad debts, Avg. monthly) _____

21. Total value added (Items 15-20) $ _____

22. Estimated total loss of value added as a result of flooding (time (months) x $ loss of value added/month) $ _____

23. Have you had flood damage in the past? yes _____ no _____

Year _____

Estimate of structure, equipment, inventory damage _____

Estimate of lost production for year $ _____

24. Do you plan to continue business operations at your current location?

_____

25. Do you plan to expand or contract business operations at this location in the next five years? _____

Survey obtained by _____

Title _____ Date _____

Table 5. Industrial Survey

Reach _____

1. Name _____

1a. Name of person providing information _____

2. Address _____

3. Industry classification _____ Sic code _____

4. Ground elevation _____ 5. Floor elevation _____

6. Zero damage elevation _____

7. Size of building (sq. ft. of floor space) _____

8. Value of structure $_____

9. Value of equipment $_____ 10. Value of inventory $_____

11. Operations information: The data requested in the following part of this questionnaire refers to your best estimate of operations over the past year (or two-three years if your business operations are significantly different this year for reasons beyond disruption from flooding).

12. Sales of goods and services (Avg. monthly) $ _____

13. Number of employees (Avg. monthly) number _____

14. Cost of labor (Avg. monthly payroll including fringe benefits, proprietors/partner salary, payroll taxes) $ _____

15. Net interest (paid less received (Avg. monthly)) $ _____

16. Profit (Avg. monthly) _____

17. Depreciation (Avg. monthly) _____

18. Business taxes (Avg. monthly) _____

19. Business transfer payments (bad debts, Avg. monthly) _____

20. Total value added (Items 14-19) $ _____

21. Estimated total loss of value added as a result of flooding (time (months) x $ loss of value added/month) $ _____

22. Do you know of any adverse impact of your down time upon any of your suppliers? _____

23. Have you had flood damage in the past? yes _____ no _____

Year _____

Estimate of structure, equipment, inventory damage _____

Estimate of lost production for year $ _____

24. Do you plan to continue business operations at your current location?

_____

25. Do you plan to expand or contract business operations at this location in the next five years? _____

Survey obtained by _____

Title _____ Date _____

which is compiled by the Internal Revenue Service. An example of this approach is demonstrated in the Appendix.

The survey concludes with questions related to the firm's past damage experience and estimates of damage, and plans for business operations at the same location in the future.

# 5. ESTIMATING THE INCOME AND EMPLOYMENT ON THE LOCAL ECONOMY

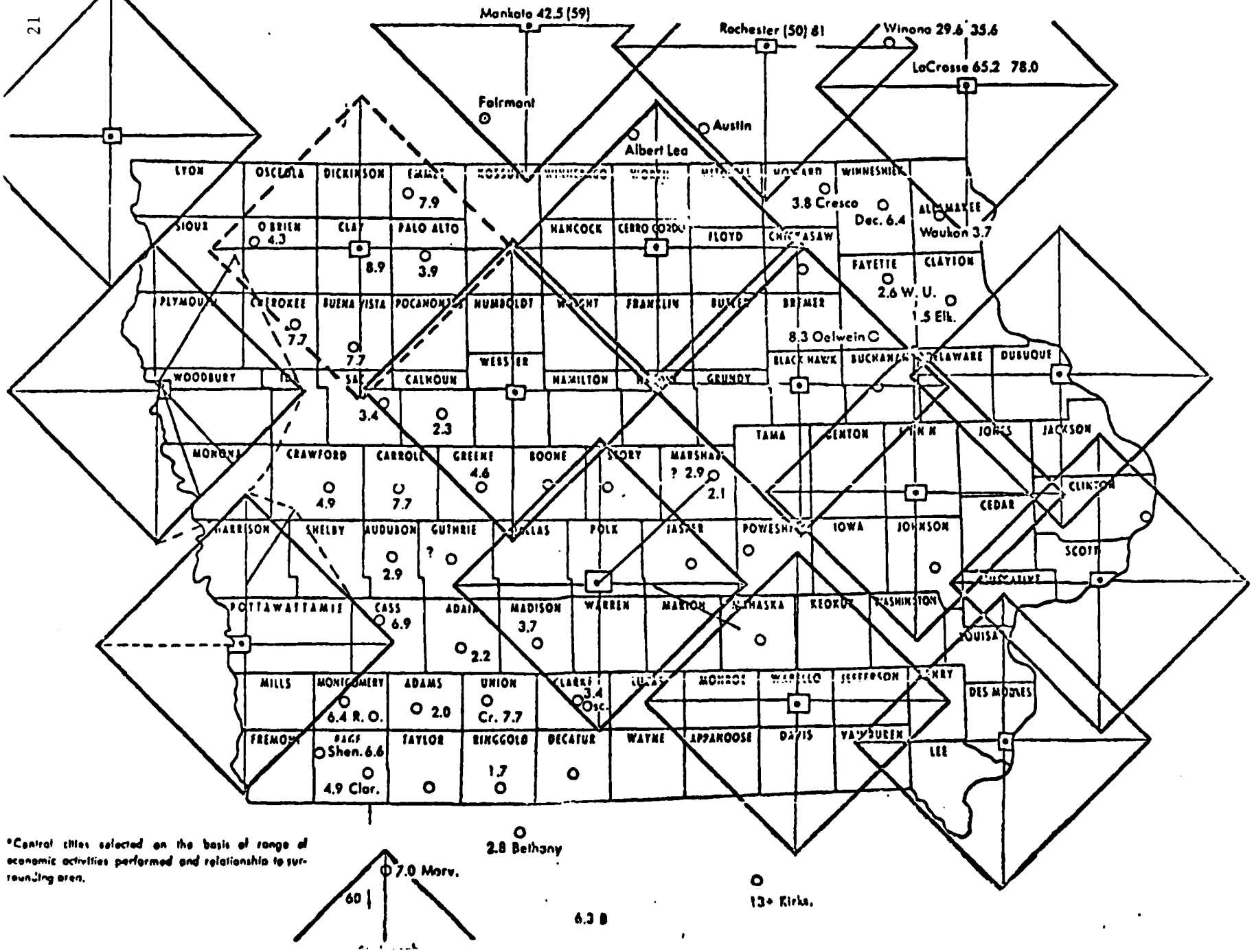
## 5.1. Delineating Economic Areas

The impact upon the local economy is somewhat difficult to measure because economic areas must be delineated within the context of political boundaries. The basic local economy should include the town or city within which the firm is located. Although the influence would likely extend to at least the local labor and trade market area, a more appropriate delineation is given by the functional economic area (FEA) as defined by Fox and Kumar (1966). The FEA is based on a major trade center and includes its labor market and shopping area within about a one hour commuting range. In Iowa the functional economic areas include the seven standard metropolitan areas of Davenport, Dubuque, Cedar Rapids, Waterloo, Des Moines, Sioux City and Council Bluffs and their labor market and shopping commuting fields within about a one hour automobile drive to the central city. Other functional economic areas in Iowa include areas focused on Burlington, Ottumwa, Mason City, Fort Dodge and tentatively Spencer. (See Figure 1).

The shape of the labor market-shopping center community fields is influenced by the road system. Since Iowa's basic road system is based on a rectangular grid system, the 55 mile per hour travel time leads to boundaries as shown in Figure 1, where distance from perimeter to FEA center is approximately 55 miles or one hour travel time. The functional economic area contains a number of small towns and cities within the one hour commuting boundary.

The extent of spillover of economic impact beyond the functional economic area would likely be relatively insignificant for the small to medium size

# 50-MILE COMMUTING DISTANCES FROM THE CENTRAL BUSINESS DISTRICTS OF ALL FEA (INCLUDING SMSA) CENTRAL CITIES IN OR NEAR IOWA*




*Central cities selected on the basis of range of economic activities performed and relationship to surrounding area.

firm. Of course the shutdown of a very large firm with thousands of employees would undoubtedly impact a larger area, even as large perhaps as a state. Clearly, judgment is required in assessing the spatial impact of a temporary plant shutdown as a result of flooding.

## 5.2. Economic Area Export-Base Multiplier

The measurement of the impacts of the loss of income and employment for the local area can be done with reasonable accuracy using export-base multiplier analysis. While an econometric model of the economic area as proposed by Ellson, Milliman, and Roberts (1984) would be the better way to approach the measurement of the impact of flooding damage, it would generally involve greater costs than justified given that alternative methods exist which are significantly cheaper to implement and which perform reasonably well.

In the export-base model, the economy is divided into two major sectors, those providing goods and services for export outside the region, and those sectors producing goods and services for the local economy. The basic theoretical construct underlying the model is that an increase (decrease) in exports from the area or region increases (decreases) the flow of income to the area. This in turn causes an increase (decrease) in demand for the goods and services provided by the service or local sector. The economic interdependence between the export sector and local sector results in a multiplier effect. It is this multiplier effect we want to estimate so that the total impact of a change in output for the area can be estimated.

The economic base model can be implemented with area employment data by determining those firms and their employment which export outside the region,

or the portion of their output which is exported outside the region, and those firms and their employment which produce only for local consumption. While the concept of whether a firm produces for export or local sector, or both, is straightforward, this determination is difficult for an urban area short of surveying every establishment. Short of surveying the entire urban area or region, three alternative approaches are suggested for deriving the export-base multiplier based on tests of multiplier accuracy (Barnard and Ballman (1979). These authors reported accuracy was best for multipliers developed from input-output or intersectoral flows analysis, next by multipliers developed using location quotients, and finally, the least accurate were multipliers developed by an ad hoc approach of assigning sectors between the export and service sectors.[3] If an existing input-output or intersectoral flows analysis model is available for the economic area, the implied economic base multiplier from this model should be used. If an input-output model does not exist, then an alternative method is needed to allocate employment into the export and service (or local) classifications.[4]

Once economic area employment has been allocated to export and local employment, the economic base employment multiplier, (K), can be estimated, i.e.,

$$K = \frac{\text{total employment}}{\text{export employment}}.$$

An example of deriving an export base multiplier is given in the Appendix.

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[3] For similar conclusions see, Isserman (1980), Gibson and Worden (1981), and Brodsky and Sartaty (1977).

[4] For instance, the assignment method which assigns the manufacturing sectors to the export sector, or the location quotient method which assigns portions of the various sectors to the export sector.

If the damage occurred to firms in the export sector, then the impact of a change in employment can be estimated as follows:

$$\Delta \text{ Total employment} = K(\Delta \text{ Export employment}).$$

Similarly, the estimated loss of the area's value added or personal income can be estimated using the same multiplier. For example, if K = 1.75 and the estimated impact on the export sector's value added is $10 million, then the total reduction of the local economy's value added is $17.5 million.

Since the basic assumption in the export-base theory is that the local sector expands or contracts based on changes induced by the export sector, if the damage occurred to firms in the service sector then the loss of a limited amount of service sector production would likely be made up by the expansion of output of the other firms in the local service sector. If, however, the impact on the local service sector were to be extensive, or the only firm serving the area of a particular kind, then clearly there would be an impact on the local service sector equal to the sum of the losses of output of the damaged firms in the local service sector.

Thus, it is important to determine if the damage is done to firms in the export, or local sector. This is because they are multiplier effects on the local economy (in addition to the direct business losses) if the firms affected are export oriented, and only the direct business losses if the firms affected are service oriented.

## 5.3. Summary

The methodology described above can be used to develop estimates of the

loss of business production from flooding. The value added measure is useful in measuring losses in that it provides a comprehensive measure comparable to the Gross National Product.

The concept of the functional economic area can be used to delineate an economic area for measuring the impact of business loss. The use of the export-base model is suggested as the means for estimating the impact of flood losses on the local area economy.

# APPENDIX

## 1. Methods for Estimating Selected Components of Value Added

The business person contacted by the interviewer to provide information on the operations of a flood damaged firm may not know, or may not feel inclined to respond to, all questions on the survey questionnaire, especially the specific questions directed to the income statement of the firm. In this case, estimates can be made based on data reported in the Internal Revenue Service (IRS) reports, Statistics of Income. The IRS publishes tax return data on firms by legal filing status, i.e., sole proprietorships, partnerships, and corporations by major industry sector. The business operations data include the components that are needed to estimate value added for the individual firms in a flood damage survey where data may be missing.

Information must be obtained from the firm (or estimated) for at least one key component related to output such as sales, number of employees, and/or payroll. If data cannot be obtained on these items from the firm, the interviewer must seek the information elsewhere, such as the local chamber of commerce, or make his own estimate of one of these basic data items and proceed from there. Number of employees is a fundamental piece of information indicating size of operation for each type of business. Once this is obtained, then an estimate of cost of labor, sales, and other items can be estimated.

The following example assumes the interviewer can only obtain number of employees and payroll data from a sole proprietorship in the printing and publishing sector of a sole proprietorship firm. From the IRS data on sole proprietorships for 1981, estimates of the other information needed to

complete the survey can be estimated using ratio estimates derived from the IRS data.

Example: Compute the following ratios from the IRS data:

Sales

$$S = \frac{\text{Income from sales and operations}}{\text{Cost of labor}} = \frac{2,930,517}{611,389} = 4.7932$$

Net Interest

$$i = \frac{\text{Interest on business indebtedness}}{\text{Cost of labor}} = \frac{41,451}{611,389} = 0.0678$$

Profit

$$p = \frac{\text{Net income}}{\text{Cost of labor}} = \frac{454,171}{611,389} = 0.7429$$

Depreciation

$$d = \frac{\text{Depreciation}}{\text{Cost of labor}} = \frac{127,355}{611,389} = 0.2083$$

Business Taxes

$$Tx = \frac{\text{Taxes}}{\text{Cost of labor}} = \frac{57,694}{611,389} = 0.0944$$

Business Transfer Payments

$$Tr = \frac{\text{Bad debts from sales or services}}{\text{Cost of labor}} = \frac{8,954}{611,389} = 0.0146$$

Estimates of the value added components for the firm in the survey can be obtained by multiplying the computed ratios for each component, e.g., for sales:

Sales of flood damaged firm = 4.793 x (cost of labor for flood damaged firm).

This procedure would be carried out with the appropriate ratio estimate for each component of value added.

# Table 6. Nonfarm Sole Proprietorship Businesses: Income Statement for Selected Industries, 1981 /Continued

[All figures are estimates based on samples—money amounts are in thousands of dollars]

| Item | Construction—Continued | | | | Manufacturing | | | | | Transportation, communication, electric, gas, and sanitary services | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Special trade contractors—Continued | | | | | | | | | | | | | |
| | Masonry, stonework, tile setting and plastering | Carpentering and flooring | Miscellaneous special trade contractors | Contractors not allocable | Total | Lumber and wood products, except furniture | Printing, publishing, and allied industries | Machinery, except electrical | Other manufacturing industries | Total | Local and interurban passenger transit | Trucking and warehousing | Other transportation | Communication, electric, gas and sanitary services |
| | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) | (25) | (26) | (27) | (28) | (29) |
| **Businesses with and without net income** | | | | | | | | | | | | | | |
| Number of returns | 63,441 | 212,835 | 253,376 | 17,022 | 257,490 | 57,823 | 53,111 | 16,275 | 130,481 | 433,979 | 34,228 | 311,366 | 56,083 | 33,280 |
| Business receipts, total | 2,946,587 | 4,508,883 | 10,726,715 | 373,553 | 13,647,822 | 3,702,875 | 2,941,967 | 938,136 | 6,064,744 | 21,868,362 | 893,328 | 16,708,501 | 2,853,984 | 1,612,549 |
| Income from sales and operations | 2,944,226 | 4,478,078 | 10,631,857 | 372,882 | 13,553,356 | 3,674,093 | 2,930,517 | 930,736 | 6,018,010 | 21,684,466 | 892,216 | 16,552,472 | 2,832,744 | 1,607,035 |
| Other business income | 2,351 | 33,423 | 97,036 | *951 | 94,440 | 28,882 | 11,448 | 7,380 | 46,728 | 183,004 | 1,112 | 155,173 | 21,205 | 5,514 |
| Windfall profit tax credit or refund | *8 | *482 | *21 | — | *25 | — | — | *20 | *5 | 892 | — | *857 | *35 | — |
| Business deductions, total | 2,458,883 | 3,407,328 | 9,252,815 | 253,435 | 12,291,388 | 3,475,570 | 2,567,572 | 719,485 | 5,528,763 | 19,814,848 | 882,792 | 15,048,452 | 2,806,808 | 1,376,795 |
| Cost of sales and operations, total | 1,341,995 | 1,966,951 | 4,439,507 | 50,880 | 8,648,484 | 1,819,830 | 1,284,955 | 316,075 | 3,427,625 | 4,487,972 | 113,624 | 2,435,912 | 1,465,316 | 473,217 |
| Inventory, beginning-of-year | 13,758 | 159,698 | 126,134 | *3,017 | 556,740 | 73,961 | 39,357 | 25,983 | 417,458 | 215,949 | *8,195 | 31,922 | 165,748 | 10,083 |
| Purchases | 408,974 | 802,648 | 1,807,568 | *27,527 | 4,063,729 | 908,780 | 611,369 | 179,140 | 2,363,410 | 2,358,060 | 94,744 | 1,354,584 | 567,808 | 340,926 |
| Cost of labor | 566,112 | 409,691 | 924,685 | *920 | 1,016,344 | 207,224 | 284,035 | 81,511 | 443,573 | 382,441 | *5,015 | 261,817 | 84,219 | 31,390 |
| Materials and supplies | 567,968 | 805,718 | 1,197,226 | 10,204 | 718,780 | 144,477 | 191,750 | 49,497 | 333,066 | 188,250 | *7,384 | 127,893 | 24,244 | 28,729 |
| Other costs | 171,677 | 234,715 | 753,526 | *11,801 | 970,600 | 386,568 | 229,673 | 11,481 | 342,878 | 1,437,026 | *7,492 | 898,141 | 672,685 | 57,699 |
| Less: Inventory, end-of-year | 386,492 | 145,715 | 169,631 | *2,383 | 677,718 | 102,191 | 71,249 | 31,517 | 472,761 | 93,754 | *8,209 | 39,545 | 29,395 | 15,009 |
| Advertising | 8,018 | 10,807 | 49,601 | 2,757 | 98,398 | 8,867 | 42,267 | 2,051 | 45,200 | 65,970 | 1,065 | 26,521 | 28,530 | 8,853 |
| Amortization | — | — | *124 | — | 4,883 | *950 | 1,801 | *2 | 2,110 | 9,018 | *25 | 6,034 | 372 | *2,588 |
| Bad debts from sales or services | *3,130 | 5,561 | 19,730 | — | 21,883 | 3,173 | 8,854 | *2,045 | 7,811 | 11,076 | *168 | 5,417 | 4,671 | 820 |
| Bank charges | 626 | 1,543 | 5,894 | *8 | 5,894 | 786 | 2,495 | 391 | 2,342 | 8,801 | *163 | 7,346 | 1,025 | 267 |
| Car and truck expenses | 129,392 | 297,842 | 525,980 | 27,440 | 353,874 | 105,053 | 63,987 | 18,534 | 166,320 | 1,606,128 | 57,698 | 1,391,626 | 64,556 | 92,247 |
| Commissions | *22,494 | 10,508 | 41,398 | *18,945 | 134,587 | 9,421 | 29,807 | *1,883 | 93,676 | 217,198 | *17,463 | 157,864 | 26,916 | 14,934 |
| Depletion | *18 | *1,488 | 1,927 | *408 | 2,081 | *909 | *797 | — | *385 | 1,700 | *500 | 1,073 | 126 | *7 |
| Depreciation | 85,580 | 128,506 | 623,045 | 23,024 | 691,630 | 265,909 | 127,355 | 57,398 | 240,969 | 1,955,989 | 47,536 | 1,804,516 | 109,301 | 134,551 |
| Dues and publications | 3,152 | 4,665 | 8,220 | *230 | 18,800 | 1,958 | 8,818 | 442 | 7,681 | 19,585 | 4,315 | 7,226 | 5,905 | 2,119 |
| Employee benefit programs | 6,972 | 2,720 | 14,880 | — | 13,879 | 2,473 | 5,203 | *1,806 | 4,584 | 20,053 | — | 17,636 | 1,005 | *1,412 |
| Freight | 1,019 | 1,146 | 17,385 | *998 | 50,882 | 14,584 | 12,868 | 3,229 | 20,277 | 75,737 | *45 | 13,057 | 62,106 | 529 |
| Insurance | 62,779 | 70,864 | 304,768 | 7,523 | 242,524 | 87,210 | 35,278 | 17,743 | 92,294 | 775,064 | 30,743 | 638,235 | 64,281 | 43,805 |
| Interest on business indebtedness | 36,674 | 55,365 | 234,771 | *3,233 | 261,842 | 86,949 | 41,451 | 18,995 | 114,448 | 757,929 | 21,638 | 599,256 | 92,728 | 44,313 |
| Laundry and cleaning | 1,114 | 1,897 | 7,778 | *53 | 8,766 | 648 | 1,936 | 815 | 3,366 | 10,586 | 885 | 6,886 | 2,484 | 329 |
| Legal and professional services | 11,037 | 9,967 | 41,838 | 717 | 80,841 | 10,278 | 16,691 | 3,870 | 30,003 | 69,647 | 4,162 | 45,481 | 9,852 | 10,141 |
| Office supplies and postage | 6,834 | 10,916 | 35,247 | 1,708 | 99,668 | 5,056 | 58,495 | 4,219 | 31,899 | 62,406 | 3,201 | 30,273 | 20,247 | 8,684 |
| Pension and profit-sharing plans | *2,153 | *209 | *3,350 | — | 11,515 | *383 | *6,732 | *872 | 3,528 | 3,412 | *472 | 2,556 | *323 | *62 |
| Rent on business property | 30,215 | 42,974 | 175,948 | *5,872 | 353,323 | 58,064 | 123,778 | 20,866 | 150,515 | 476,993 | 34,138 | 347,580 | 74,211 | 21,064 |
| Repairs | 17,166 | 27,273 | 249,377 | 11,129 | 246,491 | 145,953 | 37,122 | 6,375 | 57,042 | 1,501,873 | 44,584 | 1,357,210 | 63,957 | 36,112 |
| Salaries and wages | 281,265 | 291,125 | 839,903 | *47,724 | 1,141,129 | 405,444 | 267,118 | 95,625 | 372,942 | 1,402,287 | 40,597 | 1,048,854 | 141,898 | 171,138 |
| Jobs credit | — | — | *352 | — | *1,837 | *256 | *1,075 | *12 | *494 | *5 | — | *5 | — | — |
| WIN credit | — | — | — | — | *523 | — | *58 | — | *565 | *12 | — | *4 | *8 | — |
| Supplies | 31,142 | 75,014 | 223,188 | *12,978 | 144,091 | 29,691 | 34,082 | 21,660 | 58,657 | *11,969 | 1,139 | 85,697 | 14,303 | 10,831 |
| Taxes | 42,192 | 43,695 | 164,367 | 1,216 | 239,132 | 60,147 | 57,694 | 14,980 | 106,331 | 329,143 | 6,839 | 257,424 | 34,140 | 24,740 |
| Travel and entertainment | 9,146 | 11,271 | 39,064 | 2,802 | 88,131 | 9,155 | 23,655 | 6,413 | 48,908 | 174,177 | 1,985 | 131,926 | 30,664 | 9,603 |
| Utilities and telephone | 21,243 | 47,164 | 132,551 | 2,944 | 258,329 | 37,527 | 74,779 | 17,597 | 128,427 | 226,225 | 10,050 | 146,658 | 48,558 | 20,960 |
| Windfall profit tax withheld | — | — | 205 | — | *50 | *1 | *21 | — | *28 | 50 | — | *23 | *27 | — |
| Other business deductions | 306,535 | 301,058 | 1,052,943 | 30,987 | 1,094,394 | 495,435 | 200,764 | 85,733 | 312,463 | 5,439,896 | 139,750 | 4,678,485 | 379,207 | 244,474 |
| Net income less deficit | 486,704 | 1,102,684 | 1,476,100 | 120,126 | 1,356,424 | 227,397 | 374,394 | 218,671 | 535,961 | 2,053,514 | 110,537 | 1,660,049 | 47,175 | 223,754 |
| Net income | 538,158 | 1,170,052 | 1,740,229 | 124,460 | 1,808,186 | 318,195 | 454,171 | 238,174 | 796,648 | 2,906,274 | 150,393 | 2,240,473 | 235,784 | 278,614 |
| Deficit | 51,485 | 67,368 | 264,130 | *4,332 | 451,762 | 91,797 | 79,777 | 19,503 | 260,686 | 851,760 | 39,856 | 579,424 | 188,610 | 44,860 |

Footnotes at end of table.

## 2. Economic Area Export-Base Multipliers

Central to the derivation of the export-base multiplier is the procedure of determining which sectors, or portions of a sector, are involved in export activity from the economic area. As mentioned in the body of the report, the export-base multiplier derived from using location quotients generally produces a multiplier that yields less error in estimating the change in area economic activity than an ad hoc approach of determining export and local service activity.

The location quotient approach estimates export activity by forming a location quotient ratio for each sector, i.e.,

$$(1) \qquad Li = \frac{\frac{e_i}{e_.}}{\frac{E_i}{E_.}}$$

where,

$e_i$ = employment in the $i^{th}$ sector in the economic area,

$e_.$ = total employment in the economic area,

$E_i$ = employment in the $i^{th}$ sector in the national economy,

$E_.$ = total employment in the national economy.

If Li is greater than 1 this would indicate that the local sector was an export sector. If Li is equal to 1 then it would indicate the sector was self-sufficient, i.e., that the area produced enough output to satisfy its own requirements. If Li is less than 1 it indicates that goods and services for that sector must be imported. The extent that a sector Li is greater than 1 is an indication of the extent of export activity. If, for example, the

Li = 2, then it is assumed 50 percent of the output of the sector is exported, and thus, 50 percent of the employment of the sector would be assigned to export activity. It should be noted the location quotient method is likely to understate the area's exports, as the method assumes all local consumption of an exported good comes entirely from local production. Accordingly, judgment and additional information can improve the accuracy of the location quotient method.

In the ad hoc approach, sectors are assigned to export and service categories based on the best information the analyst has of the sectors of the area economy. Typically, most manufacturing sectors would be assigned to the export sector and the trade, utility, services, and finance, real estate and insurance sectors would be assigned to the local service sector. The construction sector takes some special consideration based upon the extent local construction firms may be involved in work beyond the boundaries of the area economy.

The basic unit for collecting and reporting employment data by state and federal agencies (State Job Service Departments in cooperation with the U.S. Department of Labor) is the county. If the area of interest is a small community, employment data will likely have to be estimated. A possible source of data is the local Chamber of Commerce which may have assembled economic data from a survey of local firms in the community. If there are no published sources of employment data for the local area, then a survey will have to be taken. A survey which included the major firms coupled with a sample of the smaller business firms from which estimates of employment can be generated for all firms in the local area could be used to generate export employment, local employment, and total employment.

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# MEASURING BUSINESS LOSSES FROM FLOODING

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